

REPORT DOCUMENTATION PA

AD-A253 229



98

Data sources:
Aspect of this
1219 Jefferson

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gathering and maintaining the data needed, and completing and reviewing the collection of in-
formation, including suggestions for reducing this burden, to Washington Head-
Quarters, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)

2. REPORT DATE

3. REPORT TYPE AND DATES COVERED

01 Feb 91 to 31 Jan 92 FINAL

4. TITLE AND SUBTITLE

OPTICAL METROLOGY OF MAGNETICALLY TRAPPED
HYDROGEN

5. FUNDING NUMBERS

AFOSR-90-0127

6. AUTHOR(S)

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

AFOSR/NE
Bldg 410
Bolling AFB DC 20332-6448
Dr Kelley10. SPONSORING/MONITORING
AGENCY REPORT NUMBER

2301/A4

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

UNLIMITED

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

DISTRIBUTION STATEMENT A
Approved for public release
Distribution Unlimited

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JUL 24 1992
S B D

92-19951



14. SUBJECT TERMS

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION
OF REPORT

UNCLASS

18. SECURITY CLASSIFICATION
OF THIS PAGE

UNCLASS

19. SECURITY CLASSIFICATION
OF ABSTRACT

UNCLASS

20. LIMITATION OF ABSTRACT

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Final report, AFOSR 90-0127B
Grant period: 2/1/91 - 1/31/92
Daniel Kleppner
Massachusetts Institute of Technology

During the period of this grant, 2/1/91-1/31/92, we completed the new version of our cold hydrogen trap and brought into operation our highly stabilized 243 nm laser system. The new trap has provisions for passing laser light through it, and reflecting it back by a steerable mirror. The light is brought to a focus on the axis of the trap where the hydrogen density is highest. Servo systems control the frequency of the laser light to within a few kilocycles of the frequency of a reference cavity, and also the position of the light beam in the cell. The excited atoms are detected by quenching them with a small electric field and observing the radiated Lyman-alpha photons with a microchannel plate detector mounted on the bottom of the trap.

We had one test run in which we searched for an optical signal from the cold trapped hydrogen, without success. Considering that this represented the first attempt to integrate laser spectroscopy with trapped hydrogen, it is not remarkable that we ran into a problem on our first attempt.

Our difficulty arose from a small amount of absorption of the 243 nm laser light in a MgF window at low temperature. There was enough heating to boil off the liquid helium film that coated the window, and the evaporating helium knocked the atoms out of the trap. As a result, we had to reduce our laser power to about 10% of the available power. Since we are attempting to observe a two-photon signal ($1S \rightarrow 2S$) which depends on the square of the power, this loss was prohibitive. We have a number of approaches for overcoming this technical problem, and are working on it.

Work on the proposed method for measuring frequency of the 243 nm has continued, chiefly with the development of a new and simpler method for employing optical parametric oscillators. An oscillator at operating at about 540 nm has been constructed and is being adapted for operation at 486 nm, the frequency of our pump laser.

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